2015

Summer Annual Forage Mixtures Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2015 SUMMER ANNUAL FORAGE MIXTURES TRIAL

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In 2015, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of six summer annual forage species and five mixtures at Borderview Research Farm in Alburgh, VT. In the Northeast, cool season grasses dominate the pastures and hay meadows farmers rely on throughout the season. With the onset of hot summer weather, these grasses enter dormancy and slow in production leading to what is generally referred to as the "summer slump." Given this decline in productivity, organic producers still must provide animals with 30% of their dry matter intake (DMI) from pasture over at least 120 days of the year. These constraints, in combination with variable weather, can make it very difficult to produce adequate forage from these cool season perennial grasses alone. Summer annual species thrive in hot weather and can be grazed to help reach the pasture requirement or can be used as stored feed to supplement other sources. Recently, there has been a growing interest in utilizing multiple species to further maximize forage yield and quality. We compared six summer annual species alone and in three-and five-species mixtures to evaluate potential differences in forage production and quality. While the information presented can begin to describe the yield and quality performance of these forage mixtures in this region, it is important to note that the data represent results from only one season and one location.

MATERIALS AND METHODS

In 2015, annual forage species and mixtures were evaluated at Borderview Research Farm in Alburgh, VT. The plot design was a randomized complete block with four replications. Treatments were 11 forage mixtures/species evaluated for forage yield and quality. Forage treatments and seeding rates are summarized in Table 1.

Table 1. Summer annual forage species and mixtures evaluated in Alburgh, VT.

Abbreviation	Species	Seeding rate (lbs ac^{-1})	
		Alone	In mixture
M/ V/ Ch	Wonderleaf Millet	20	10
	AC Greenfix Chickling Vetch	60	30
	TFL 200 Chicory	6	3
S/ Cl/ Ch	Hayking Sudangrass	50	15
	Berseem Clover	15	8
	TFL 200 Chicory	6	3
R/ Cl/ Ch	Fria Annual Ryegrass	30	15
	Berseem Clover	15	8
	TFL 200 Chicory	6	3
S/ M/ Cl/ V/ Ch	Hayking Sudangrass	50	15
	Wonderleaf Millet	20	10
	Berseem Clover	15	8
	AC Greenfix Chickling Vetch	60	30
	TFL 200 Chicory	6	3

M/ R/ V/ Cl/ Ch	Wonderleaf Millet	20	10
	Fria Annual Ryegrass	30	15
	AC Greenfix Chickling Vetch	60	30
	Berseem Clover	15	8
	TFL 200 Chicory	6	3

The soil type at the Alburgh location was a Benson rocky silt loam (Table 2). The seedbed was chisel plowed, disked, and finished with a spike tooth harrow. The previous crop was winter barley. Plots were 5’ x 20’ and replicated 4 times. The trial was planted with a Great Plains cone seeder on 7-Jun. Plots were harvested with a Carter forage harvester on 29-Jun. At the time of harvest, plots were experiencing very high weed pressure from other grasses. To avoid misrepresenting the yield and quality of the intended crop, only a portion of the plots were harvested. Plots that had low weed biomass and most of the planted species present were harvested. After harvest, all the remaining plots were mowed to the same height. A second harvest of the same plots was taken on 31-Aug.

Table 2. Annual forage trial management, Alburgh, VT, 2015.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Winter barley
Tillage operations	Chisel plow, disk and spike tooth harrow
Planting equipment	Great Plains cone seeder
Treatments (species/mixtures)	11
Replications	4
Plot size (ft)	5 x 20
Planting date	7-Jun
Harvest dates	29-Jun and 31-Aug

An approximate 1 lb subsample of the harvested material was collected, dried, ground, and then analyzed at the University of Vermont’s Testing Laboratory, Burlington, VT, for forage quality. Dry matter yields were calculated.

Forage quality was analyzed using the FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Dried and coarsely-ground plot samples were brought to the lab where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. The samples were then analyzed using the FOSS NIRS DS2500 for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), 30-hour digestible NDF (NDFD), and total digestible nutrients (TDN).

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility (NDFD). Evaluation of forages and other feedstuffs for NDFD is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDFD. Forages with increased NDFD will result in higher energy values and, perhaps more importantly, increased forage intakes. Forage NDFD can range from 20 – 80% NDF.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and mixtures were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In the example above, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Hybrid	**Yield**
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

RESULTS

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 3. From June through August, there was an accumulation of 1670 Growing Degree Days (GDDs) in Alburgh which is 25 fewer than the 30-year average. Rainfall was above average during planting, with over 6 inches of rain in June. This rainy weather during planting caused slow establishment allowing grassy weeds to dominate the trial area. The remainder of the growing season had below average precipitation with August being the driest with almost 4 inches less rain than normal. Temperatures during the season did not drastically fluctuate from the long term average.

Table 1. Seasonal weather data[1] collected in Alburgh, VT, 2015.

Alburgh, VT	June	July	August
Average temperature (°F)	63.1	70.0	69.7
Departure from normal	-2.7	-0.6	0.9
Precipitation (inches)	6.42	1.45	0.00
Departure from normal	2.73	-2.70	-3.91
Growing Degree Days (base 50°F)	416	630	624
Departure from normal	-58	-10	43

[1]Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Impact of Variety

Due to excessive rainfall and cool temperatures during June which caused slow establishment of the treatments, high weed pressure was observed across the trial area. To avoid misrepresenting the species and mixtures only plots in which the planted species had established significantly were harvested. Omitted treatments included the vetch, chicory, and clover planted alone, as well as the S/M/Cl/V/Ch mixture.

Treatment significantly impacted dry matter yield and CP levels across both cuts (Table 4, Figure 1). Single species appeared to establish and also produce higher yields than the mixtures. The treatment with the highest dry matter yield was the 'Hayking' Sudangrass which produced 2.76 tons ac^{-1} of dry matter, one ton higher than the trial average of 1.85 tons ac^{-1}. The mixture of M/R/V/Cl/Ch also yielded well and may indicate that ryegrass and millet complement each other in their growing habits. The lowest yielding treatment was the R/Cl/Ch mixture which produced 1.38 tons ac^{-1}. This mixture produced about the same yield as the ryegrass only treatment (1.43 tons ac^{-1}) indicating that the clover and chicory did not establish well when planted mixtures or monocultures. Poor establishment was likely a result of the wet and cool weather experienced immediately following planting. The goal was to add legume to the mixtures to increase CP concentrations of the forages. The addition of legume actually caused a decline in the CP concentration of the forage compared to the single grass species treatment. This may indicate that percentage of legume in the mixture was not adequate to increase CP of the mixture. The treatments did not statistically differ from one another in terms of ADF, NDF, or NDFD.

Table 4. Yield and quality of seven summer annual forage treatments, 2015.

Abbreviation	DM Yield	Crude protein	ADF	NDF	NDFD	Cost	
	tons ac^{-1}	% of DM	% of DM	% of DM	% of NDF	Dollars ac^{-1}	Dollars DM ton^{-1}
M/ V/ Ch	1.51	15.3	33.4	58.6	**53.7**	64.50	42.78
S/ Cl/ Ch	1.95	16.2	32.9	58.0	50.7	65.65	33.61
R/ Cl/ Ch	1.38	16.1	33.2	58.4	51.7	45.70	33.18
M/ R/ V/ Cl/ Ch	2.07	16.6	31.9	57.1	47.8	93.10	45.08
Millet	1.84	18.0	**31.2**	58.2	51.1	34.80	18.91
Sudangrass	**2.76**	18.0	33.1	59.5	48.3	100.50	36.41
Ryegrass	1.43	**18.5**	31.7	**56.3**	50.6	**20.40**	**14.31**
Probability level	***	***	NS	NS	NS	N/A	N/A
Trial Mean	1.85	17.0	32.5	58.0	50.5	60.58	32.04

Treatments in bold indicate the top performer for that parameter.
NS-Not statistically significant.
*,**,***- treatments varied statistically at the .1, .05, or .001 significance level respectively.

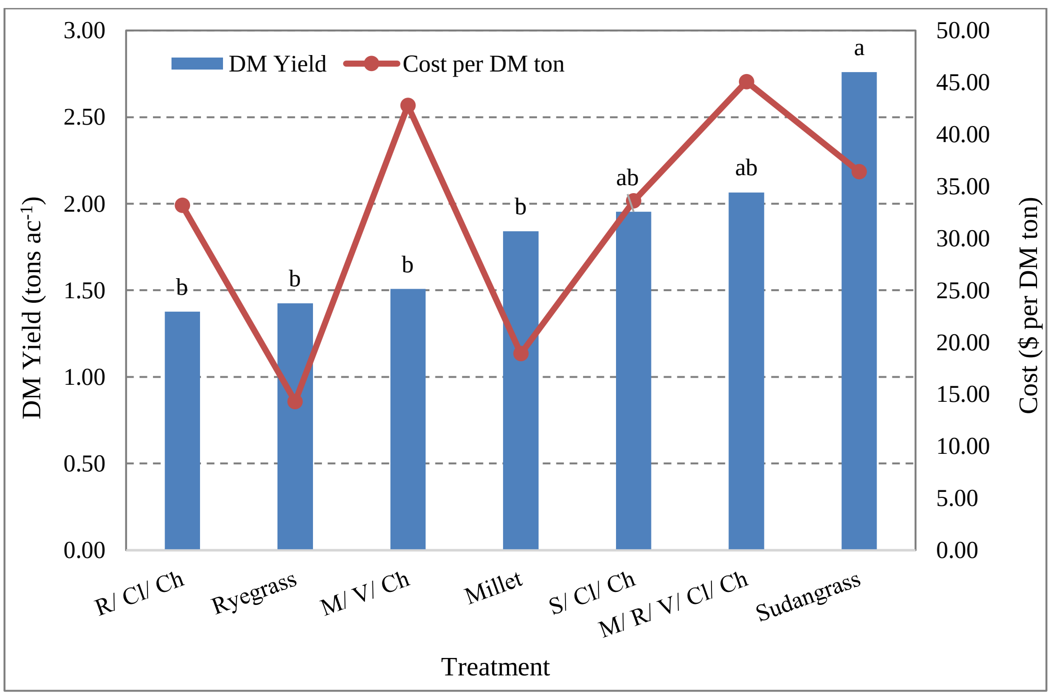

Figure 1. Dry matter yields and cost per ton of dry matter for 7 forage mixture treatments. Treatments that share letters did not statistically differ from one another.

Impact of Cut

The treatments were harvested twice over the season. The harvests varied significantly in terms of yield, protein, and NDF (Table 5). The highest yield of 2.3 tons ac^{-1} of dry matter was observed in the first cut which was one ton higher than the second cut. Protein was also higher in the first cut at 17.4% compared to 16.6% in the second cut. NDF was lower in the 2nd cut at 55.6% compared to 60.5% in the 1st cut. The concentrations of ADF and NDFD did not vary significantly by cut.

Table 5. Yield and quality of two harvests of 7 summer annual treatments, 2015.

Cut	DM yield	Crude protein	ADF	NDF	NDFD
	tons ac^{-1}	% of DM	% of DM	% of DM	% of NDF
1st	**2.3**	**17.4**	34.7	60.5	**50.6**
2nd	1.4	16.6	**30.2**	**55.6**	50.5
Probability level	***	***	NS	***	NS

Treatments in bold indicate the top performer for that parameter.
NS-Not statistically significant.
*,**,***- treatments varied statistically at the .1, .05, or .001 significance level respectively.

Although differences in quality and production by cut are expected, this information may influence producers' management from an animal nutrition perspective.

DISCUSSION

From these data it appears that, of the treatments that were harvested, the annual grasses yielded higher than the mixtures containing the legumes and chicory. The exception was the mixture that included annual ryegrass and millet that yielded higher in combination than either of these species planted alone. This may indicate that these two grasses have complimentary growth habits and further research should be conducted to evaluate the benefits of the mixture. The chickling vetch, berseem clover, and chicory did not establish well, the higher costs of the seed was not recouped in yield for the more complex mixtures. The prolonged wetness and severe weed pressure likely influenced stand establishment of these species. Additional years of research need to be conducted to fine tune seeding rates and benefits of mixtures in these annual forage systems.

However, it is important to remember that these data only represent one year, in which challenging weather was experienced causing high weed pressure. In addition, seeding such complex mixtures with highly varying seed size is a challenge to attain a uniform seed mixture going out of the seeder. This could also have contributed to the weed pressure as if there were any skips and clumps in seeding there could be gaps leaving the stand vulnerable to weeds. This poses a challenge for creating mixtures that perform well together, not only for forage production and quality, but are consistent and do not pose significant seeding challenges for farmers. We will continue to trial these mixtures in hopes of determining mixtures that are suited to our growing region and farming operations.

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